

Issues/Problems

Agriculture directly affects more than 50% of the land use in the lower 48 States and indirectly affects an even larger proportion of the Nation's terrestrial, aquatic, and marine resources. Emphasis of agriculture has shifted from small family-owned farms to larger operations, intensifying agricultural practices on a given area. Globally, farmers cultivating the land move about 10^{15} metric tons of soil per year: an enormous and totally new intervention in the life-zone of the Earth (Chesworth, W., Sustainability and the End of History, Geotimes, October 2002, p. 51-52). Rapid technological advances in the U.S. since World War II have shaped the development and character of the agricultural industry resulting in increasingly profound changes across the American landscape. Consequently, effects of agricultural production on environmental quality are of increasing concern to the American public. Most of the native forests in the Midwest have been converted to agricultural production, as have most prairies and wetlands in the Great Plains states. Intensification of agricultural production, enabled largely through increased use of fertilizers and pesticides and dependence on larger, specialized equipment, has resulted in substantial simplification of ecosystem diversity across much of the agricultural landscape. Intensified cropping practices and fewer, less frequent rotations of crops contributes to greater reliance on agrochemicals to maintain productivity and control pests. The loss of idle, non-farmed land has eliminated many natural areas, which in combination with less dependence on pasture and haylands, and less diversity in crops, affects the distribution and quality of habitat for both resident and migratory wildlife. Invasive species are also a concern. Confined-animal feeding operations (CAFOs) are growing rapidly and may result in large loadings of animal feed- and waste-related substances, increasing the amounts and types of pathogens and possible endocrine-disrupting compounds in the environment.

Streams and surficial sand and gravel aquifers are particularly vulnerable to agricultural contamination. Contamination from nonpoint sources of sediment, nitrogen, phosphorus, pesticides, bacteria, and newly emerging issues (i.e. pharmaceuticals, hormones, genetically-modified crops) are of growing concern. The Upper Mississippi River Basin is a major source of nutrients that cause hypoxia in the Gulf of Mexico. Effects of agricultural practices on soil geochemistry are relatively unknown from a landscape perspective. In addition to effects on water quality and stream biota, the sheer volume of water required to supply crops and animals is, in some regions, in competition with water for urban and residential areas.

Agricultural practices, in all their myriad aspects, result in a complex spectrum of effects on the Nation's terrestrial and aquatic resources. Understanding the consequences of these effects requires a holistic assessment paradigm incorporating the multidisciplinary expertise of USGS science and a long-term, dedicated effort. Because large changes in environmental effects are expected to occur with changes in agricultural practices over the next decade (supported by authorized Farm Bill spending of up to three billion dollars per year on conservation measures), it is incumbent on the USGS to act now to increase

our activity in understanding the environmental effects of agriculture and agricultural changes across the country.

Stakeholders

This initiative will supplement our programs with capabilities to work collaboratively with DOI, USDA, States and others to extend our science to areas in order to demonstrate the environmental effects of, and ultimately help to improve, the application of conservation practices on agricultural lands. In order to take this next step, we need to identify, with our partners, a number of watersheds and critical habitat areas in which significant changes in agricultural practices are occurring or are planned. The areas selected will need to encompass a range of agricultural practices in numerous landscape, hydrogeological, and climatic settings across the Nation. We need to develop collaborative monitoring, assessment, and research in these areas. We need to modify the delivery of our existing relevant environmental science and data for use by land managers selecting and applying agricultural practice changes. These activities will benefit all major stakeholders and the general public.

Among our most important stakeholders and collaborators that would support and benefit from a Central Region focus on “Environmental Effects of Agricultural Practices” are the DOI agencies responsible for resource management, Tribes, USEPA (especially Regions 5,6,7,8), U.S. Department of Agriculture (USDA) and its associated agencies: Natural Resources Conservation Service (NRCS); Agricultural Research Service (ARS); Cooperative State Research Education and Extension Service (CSREES); and Farm Service Agency (FSA). Other stakeholders with a vested interest include States, Interstate compact organizations, State Land Grant Universities, and a multitude of national, regional, and local farm interest groups (such as Farm Bureau, Soil Conservation Districts, Water-Supply Districts, Drainage Districts).

Opportunities for Integration

The initiative “Environmental Effects of Agricultural Practices” provides a prime cross-fertilization opportunity for projects across all USGS disciplines to develop a scientifically integrated approach to extend our existing research and scientific understanding into areas in which significant agricultural practice changes are occurring. For example, USGS has conducted multi-faceted agricultural research and studies for over several decades in the National Water Quality Assessment (NAWQA) Program; the Toxics and Contaminant Biology Programs; the Cooperative Water Program; the Ecosystems, Fisheries and Aquatic Resources and Invasives Programs; the Mineral Resources Program; and a few others. However, the areas studied in these programs are not co-located with areas that are undergoing significant and well-documented agricultural changes. In fact, most research avoids these areas because changes confound basic research unless change is included in the research plan.

Due to the multidisciplinary expertise of scientists in the U.S. Geological Survey (USGS) and collaborations with a broad array of other Federal and state science agencies,

universities and non-government research organizations, we are uniquely qualified to conduct long-term integrated research and monitoring designed to provide a holistic assessment of the effects of agricultural practices on the Nation's resources and make this information available for use in resource management and planning. For example, the USGS has extensive capabilities in ecology, environmental toxicology and chemistry, hydrology, species biology, geochemistry, geology, geography, economics, water quality, remote sensing, GIS and mapping, and data management and information science. Also, the USGS has continuing co-operative agreements with a wide variety of Land Grant Universities conducting agricultural related research across the Nation. This initiative provides an opportunity to build on the skills and scientific infrastructure we have developed to undertake innovative, integrated projects that incorporate all USGS disciplines, as well as expand geographic coverage and the scope of agricultural practices addressed.

USGS Program Goals

- Many USGS Programs currently have components that could contribute to a coordinated, multidisciplinary program to address impacts of agricultural practices. A few specific examples of program contributions are listed in the table below.
- The Director's Future Science Direction on "Ecosystem Health, Sustainability, and Land Surface Change" is consistent with this science priority in its goal to document past and present changes to the land surface, and to assess the condition and status of our Nation's ecosystems and the resources they provide. The expansion of agricultural land "is now widely recognized as one of the most significant human alterations to the global environment". (Loveland, et.al., Science Strategy Paper, http://internal.usgs.gov/director/fsd/doc/eslsc_draft.doc)
- Several PC/REX science themes are interwoven with the issues surrounding the impacts of agricultural practices. These include the following: Monitoring, Forecasting Landscape Change, and Status and Trends.

Strategy—See Issues/Problems section for science relevance and science impact.

The goal of this initiative "Environmental Effects of Agricultural Practices" is to use our existing interdisciplinary science expertise to address the DOI strategic goal of resource protection to protect the Nation's natural, cultural, and heritage resources by improving the health of watersheds, landscapes, and marine resources. The DOI strategic goal of serving communities is addressed through advancing scientific knowledge and improving the quality of life in the communities we serve by providing scientific leadership and information to those who make agricultural land management and conservation decisions.

USGS Programs

Discipline	Program	Selected Contributions to Ag Practice Monitoring, Assessment, Research
Biology	Contaminants Biology	Conducts ongoing research on the presence and potential effects of pesticides and other agriculturally related contaminants.
	Ecosystems	Addresses improved approaches for wetland restoration and incorporation into overall agricultural management practices.
	Fisheries and Aquatic Resources	Addresses aquatic resource health and environmental interactions such as erosion, deposition, increased turbidity, eutrophication and agricultural and aquacultural chemicals.
	Wildlife and Terrestrial Resources	Addresses factors, including farming and ranching activities, affecting the population dynamics of large predators.
	Status and Trends	Produces and provides analyses and reports synthesizing information on our Nation's flora, fauna, and ecosystems' response to numerous influences, including those of agricultural practices.
	Invasives	Works to sustain biological communities and combat invasive species through early detection, monitoring, alternative management and control approaches, including agricultural lands (forest, cropland, rangeland).
Geography	Cooperative Topographic Mapping	Established a cost-sharing program with the USDA (NRCS and FSA) to ensure the public domain availability of digital orthophoto quadrangle (DOQ) data, used extensively by farmers and others to track status of land use on agricultural fields.
	Geographic Analysis and Monitoring	Can assist the agricultural community in understanding changes occurring on the land surface and why, and the impacts of these changes on ecosystem health, climate variability, biogeochemical cycles, hydrology, and human health.
	Land Remote Sensing	Provides remotely-sensed data and expertise to problems such as identifying the sources of agricultural chemicals on the landscape, monitoring the environmental impacts of CAFO's, the study of the timing of biological events, and drought monitoring.
Geology	Earth Surface Dynamics	The "Dust Studies" project is investigating management of lands to minimize wind erosion as part of a larger Global Change Research program.
	Mineral Resources Program	Conducting a feasibility study for a soil geochemical survey of North America (with NRCS), which is critical in recognizing and quantifying changes to the composition of soil resulting from agricultural practices and other human activities.
	National Cooperative Geologic Mapping	Collects, processes, analyzes, translates, and disseminates earth-science information through geologic maps which helps to determine which land areas are suitable for agriculture.
Water Resources	Ground Water Resources	Conducts studies of critical ground-water issues, such as assessment of ground- and surface-water interaction related to irrigation and studies of ground-water depletion and water use.
	NAWQA	Provides long-term data on changing water-quality and biological trends, process understanding and occurrence data for making decisions about source-water protection, pesticide registration, nutrient criteria, ecological effects, and for implementing best management practices at local and state levels.
	Toxic Substances Hydrology (Toxics)	Investigates the fate and occurrence of agricultural chemicals, focusing on characterizing the processes that affect dispersal of chemicals in the atmosphere, ground water, and surface water; identifying persistent degradation products; and developing methods to measure these compounds in water samples at environmentally relevant concentrations.
	National Streamflow Information Program	Provides streamflow information and critical data during floods and droughts, and periodically assesses streamflow characteristics as a result of land-use change, water use, and climate, which are critical to the agricultural community.
	Cooperative Water Program	Collects data and assess effects of agriculture on surface- and ground-water quality and biota, including eutrophication and sedimentation, effects of pesticides and other agricultural chemicals, aquifer contamination, and storm runoff. Provides data and understanding for States needs for total maximum daily loads (TMDLs) and requirements of the Clean Water Act.

Next Steps and Performance Metrics

It is anticipated that in FY 2005, a variety of tasks will be undertaken to prepare for this initiative. These tasks include: develop an inventory of existing USGS projects related to agricultural practices issues; investigate opportunities to improve communication of scientific results and access to interdisciplinary data sets; hold formal USGS customer listening sessions and obtain feedback on priority issues; prepare a USGS science plan that addresses priority environmental scientific information and data needs in support of DOI and other stakeholders; and develop detailed workplans for FY 2006 and out years. See table below for more detail.

Within Current Budget	Date	With Additional Resources	Date
Prepare FY06 budget initiative	Mar 04		
Inventory of existing programs and projects in CR (living web-based)	April 04	Publish Fact Sheet on current CR activities that contribute to ag practices	Dec 04
Collection, from Director's office, of relevant, formal listening session needs and feedback on USGS science that applies to agricultural practices	April 04		
Encourage collaborative interdisciplinary monitoring, assessment, research opportunities	ongoing		
Explore opportunities for additional funding within and outside USGS	ongoing		
Hold internal workshop to further develop CR ag practices priorities from a USGS perspective with known, available external input (include important contacts outside CR)	June-July 04		
Share CR ag practices priorities with USGS programs at PC-REX mtg	Oct 04	Hold formal CR customer listening sessions and get feedback on priorities	Oct-Nov 04
Develop list of target NGOs and all potential non-traditional partners for ag practices communications (eg: Ducks Unlimited)	Nov 04		
Work with CR Office of Communications to publicize USGS ag work (press release?)	Dec 04	Investigate opportunities to improve science communication, access to interdisciplinary data sets through web development	Mar 05
Finalize CR ag practices priorities using external perspectives	Dec 04	Publish CR ag practices science plan	May 05
Plan activities for remainder of FY05, FY06	Dec 04		
Plan out year (FY07-10) activities	Spring 05		